Space Weather Technical Forecast

Issued on Friday 17 January 2025 at 13:30 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Isolated M-class flares likely throughout. Chance isolated G1/Minor Geomagnetic Storm, mainly 17-18 Jan.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with isolated M-class flares, peaking M2.0 at 17/0919 UTC from AR3964 in the northwest. There are currently seven regions on the visible disc, three of which are of note due to their size or complexity. AR3964 continued to develop through the period, and is now magnetically complex, with the emergence of two to three small delta spots. AR3961, in the southeast is a moderately sized region with at least one delta spot emerging over the past 24-hours. AR3959 in the northeast is the largest region on the disc, but has a simple magnetic structure, and appears to be gradually declining with the penumbra around the trailing spots decaying. The remaining regions are smaller and magnetically simple.

No Earth-bound CMEs were observed in available imagery. One eruptive feature associated with a filament disruption around 16/2200 UTC is yet to be modelled by Enlil and may have produced a CME with a slight Earth-bound component, although this is low confidence.

Solar Wind / Geomagnetic Activity: Ongoing fast wind influence was observed attributed to connection to a HSS from CH09/-. Solar wind speeds were initially slightly elevated at 400-430 km/s. Wind speeds remained steady, before gradually increasing from around 17/0400 UTC and are now at Elevated levels around 530 km/s. Density was below average. Interplanetary Magnetic Field, Bt, was Weak, rising to Moderate around 16/2200 UTC with a peak of 11nT. The north-south component, Bz, Weakly fluctuated until around 16/2300 UTC, but has since fluctuated Moderately, ranging between +9/- 10nT. Phi angle was predominantly negative (towards the Sun). Geomagnetic activity was mainly Quiet to Unsettled (Kp 2-3), but with one Active (Kp 4) interval 16/1800-2100 UTC.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES-18 was Background. High energy electron flux (greater than 2MeV) at GOES16 was Background to Moderate with the associated 24 hour fluence below the Active threshold. This reached 1.37e7 integrated pfu at 17/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is expected, with isolated M-class flares likely. There is a slight chance of an X-class flare, most likely emanating from AR3964 in the northwest, or AR3961 in the

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southeast.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs currently expected. Ongoing coronal hole influence expected to continue, associated with CH09/- an elongated coronal hole that stretches out in a band across the solar equator. The associated enhanced solar winds, at Elevated levels, are expected to persist for the rest of the period, perhaps peaking around 600 km/s. Wind speeds are expected to begin to wane through Day 4 (20 Jan) towards Slightly Elevated levels. Quiet to Unsettled (Kp 2-3) geomagnetic activity is expected with isolated Active (Kp 4) intervals. There is a chance of reaching a G1/Minor Geomagnetic Storm interval, most likely during Days 1-2 (17-18 Jan).

Energetic Particles / Solar Radiation: GOES18 high energy proton flux is expected to remain at background. GOES-16 high-energy electron flux is anticipated to be at predominantly Moderate levels, perhaps temporarily reaching High at times during the peaks of the diurnal cycles. The associated 24 hr fluence is expected to persist below Active (1e8 integrated pfu), but with a gradually increasing trend.

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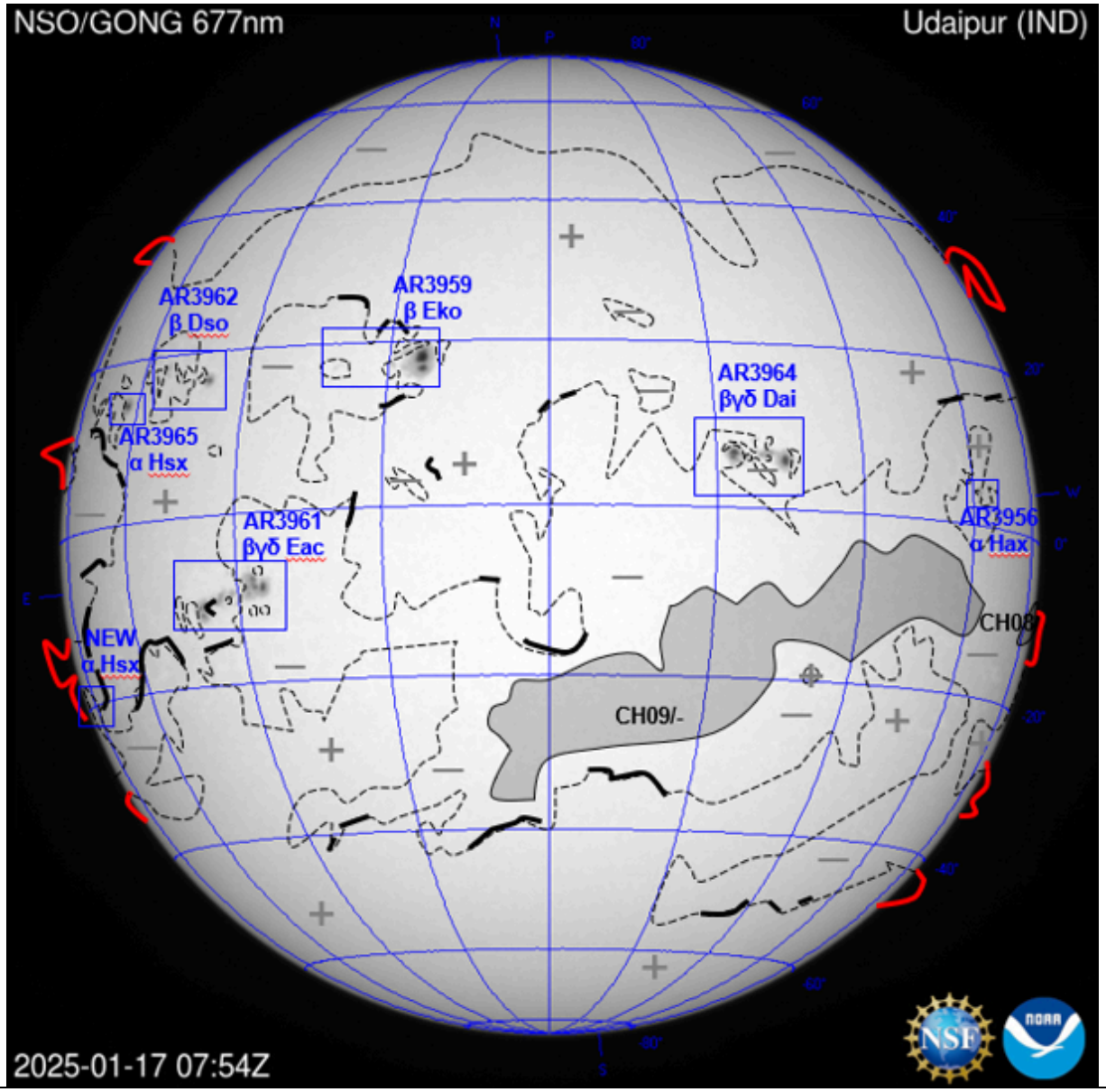
Figure 1: Solar Synoptic Map VT 17/0800 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There are no Earth-directed CMEs currently expected. Recent flaring from AR3964 in the northwest does not appear to have produced any eruptive CMEs. An eruptive feature visible leaving the southwest disc around 16/2200 UTC is yet to be modelled by Enlil, but is not expected to have an Earth-directed component.

The solar wind outlook is dominated by the broad coronal hole across the centre of the disc, CH09/-. Due the longitudinal width of this feature, ongoing fast wind influence is likely to continue throughout the period, with Elevated solar winds mainly expected, with a chance of strengthening towards 600km/s at times. From Day 4 (20 Jan), the coronal hole largely lies in the southern hemisphere with any influence expected to gradually wane, and associated wind speeds decline back towards Slightly Elevated (400 km/s) levels.

This ongoing enhancement is supported in MOSWOC Enlil output, although this is perhaps slightly over-estimating the longevity of the feature and the peak wind strength.

Quiet to Unsettled (Kp 2-3) geomagnetic activity is expected with isolated Active intervals (Kp 4). There is a chance of reaching a G1/Minor Geomagnetic Storm intervals (Kp 5), most likely today or tomorrow (17-18 Jan).

Geomagnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	40	40	20	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Figure 2: MOSWOC Enlil, currently considered to be giving good guidance.

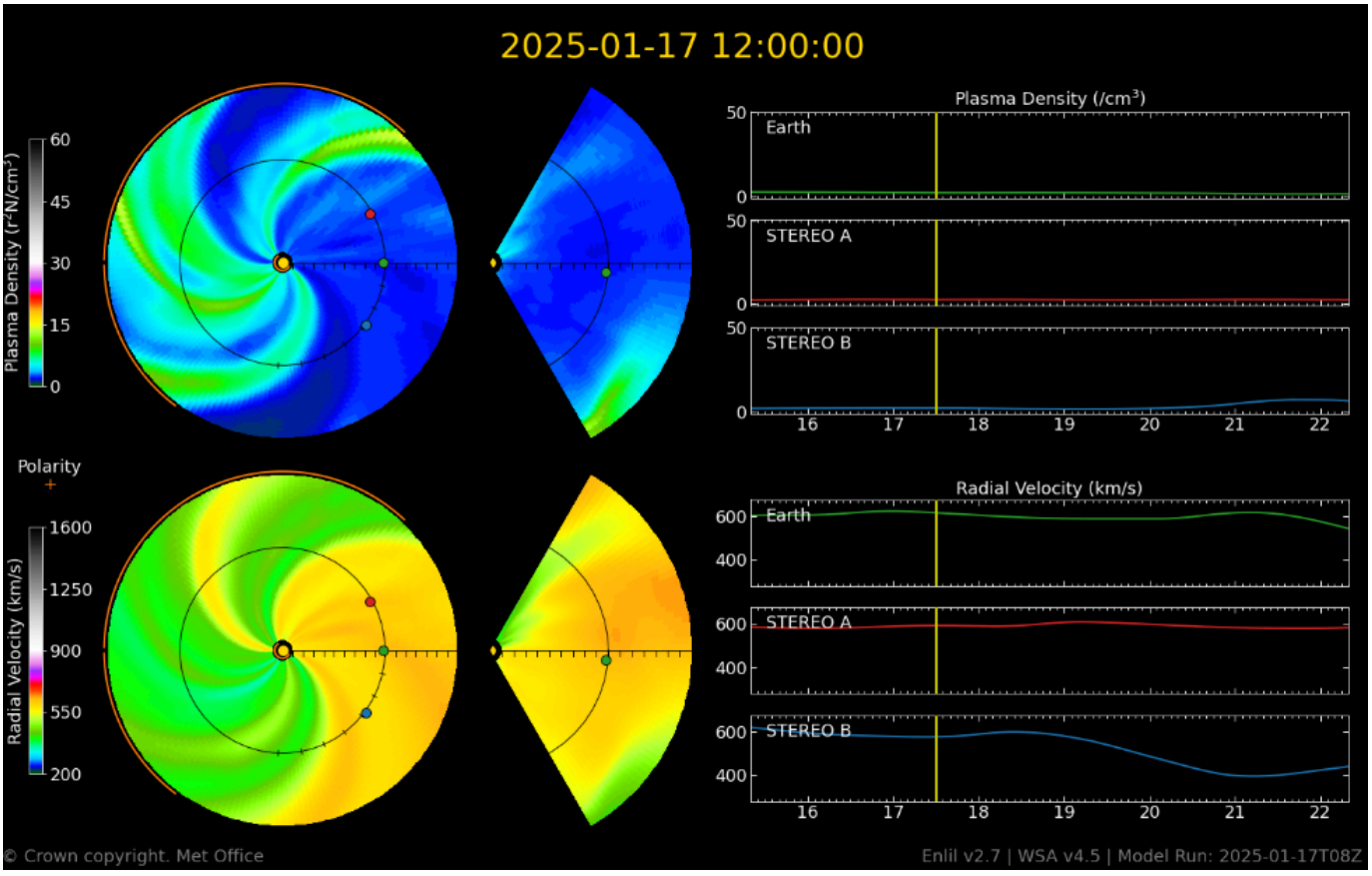
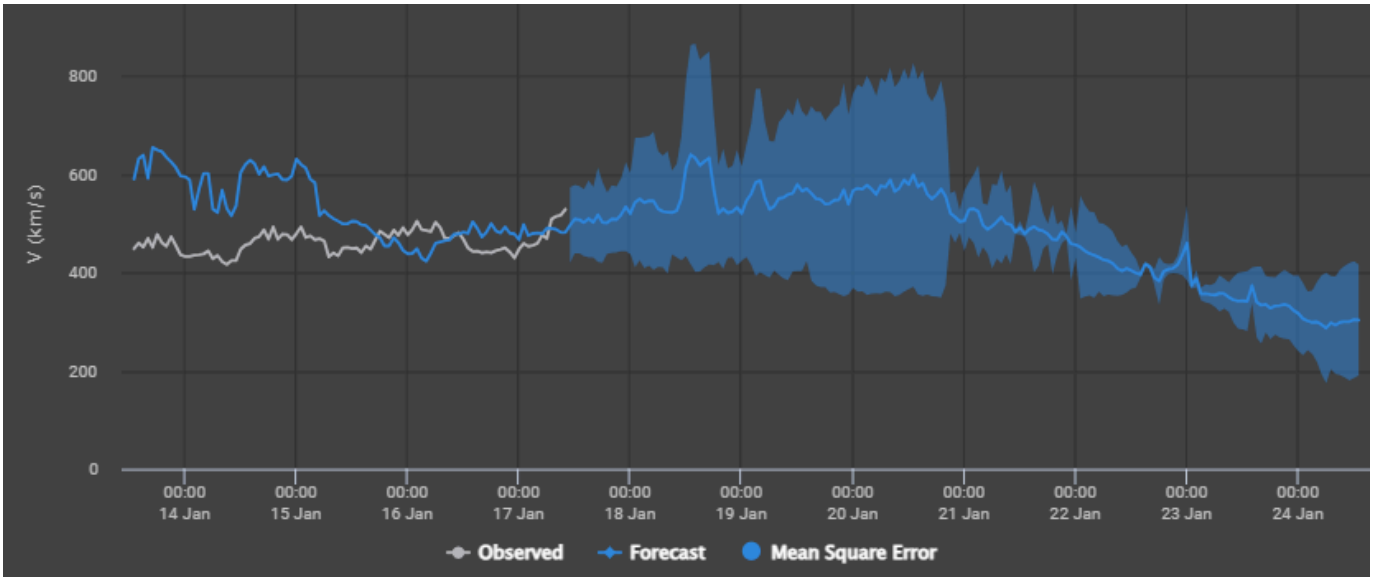


Figure 3: MOSWOC REFM considered to be giving a reasonable steer in wind strengths through the period.



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Radio Blackouts - X-Ray Flares

There are currently seven regions on the visible disc with AR3963 having faded to plage and an unnumbered region emerging from the southeast limb. AR3964 (Dai/Beta-Gamma-Delta) and AR3961 (Eac/Beta-Gamma-Delta) are the most complex regions on the disc. AR3964, in the northwest, has continued to increase in spot number and is approaching compact configuration. The region consists of two strong asymmetric spots at either end with numerous intermediate spots and the presence of at least three small delta spots within the intermediate portion. AR3961, in the southeast, has recently seen further growth within its intermediate spots and the emergence of a delta region in the intermediate spots. The largest region on the visible disc remains AR3959 (Eko/Beta), in the north east. This region is dominated by the large leader spot, but has seen significant fading of the trailer region to the east, which appears connected in SDO aia-imagery. The unnumbered region in the southeast is currently analysed as a Hsx/Alpha. The remaining regions are smaller, stable and magnetically simple.

Bright regions visible close to the eastern limb along with far-sided helioseismology suggest the return or emergence of one or more sunspot regions during the period, this is not necessarily reflected in the current flare probabilities.

The risk of isolated M-class flares remains likely, mainly from AR3964 or AR3961. There is also a slight chance of an isolated X-class flare.

X-Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 (M Class)**	Yes	60	60	50	50
Very Active	**R3-R5 (X Class)**	No	10	10	10	10

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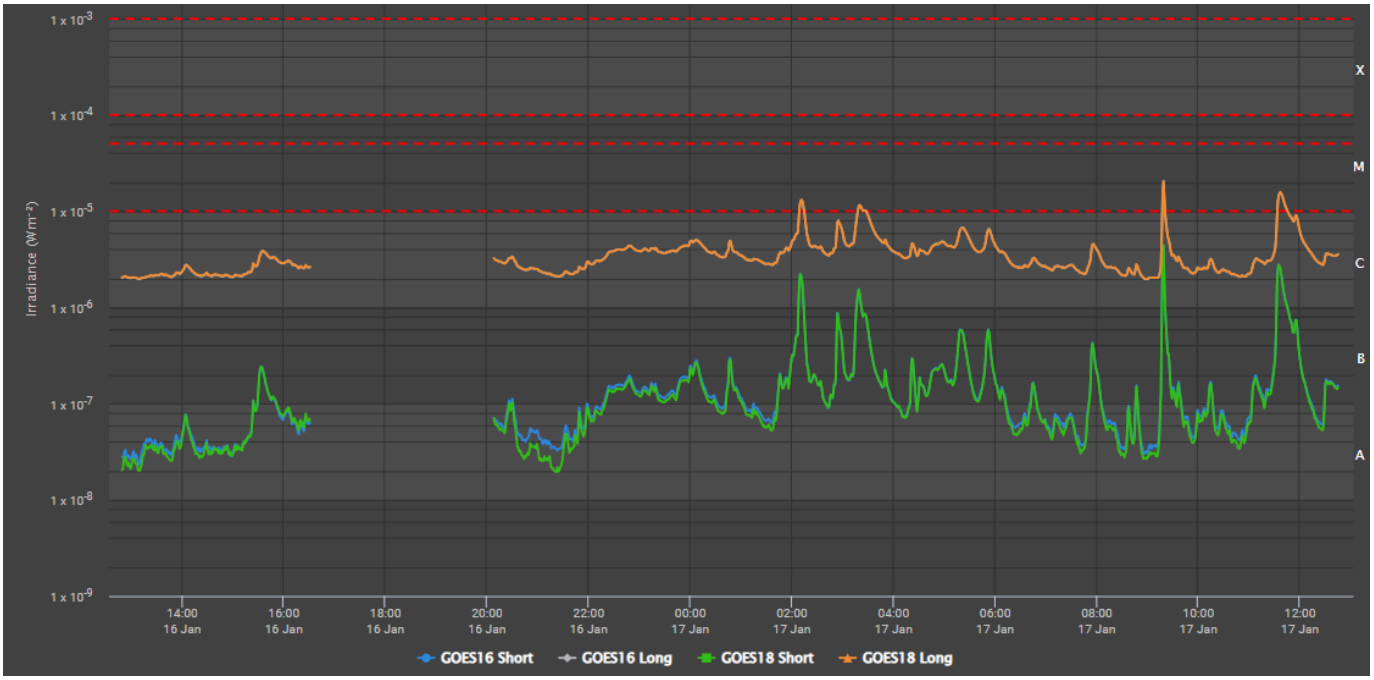
Figure 4: GOES16 and GOES18 Irradiance X-ray trace over the past 24 hours, note the outage 16/1600-2000 UTC



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Solar Radiation Storms (High Energy Protons)

GOES18 high energy proton flux has remained at background levels over the last 24 hours and is expected to persist at this level. However, AR3964 has recently rapidly developed in the northwest to become a magnetically complex region. If AR3964 becomes more active, and produces significant flares, this could potentially lead to proton events being observed at Earth, although currently there is only a slight chance of this occurring.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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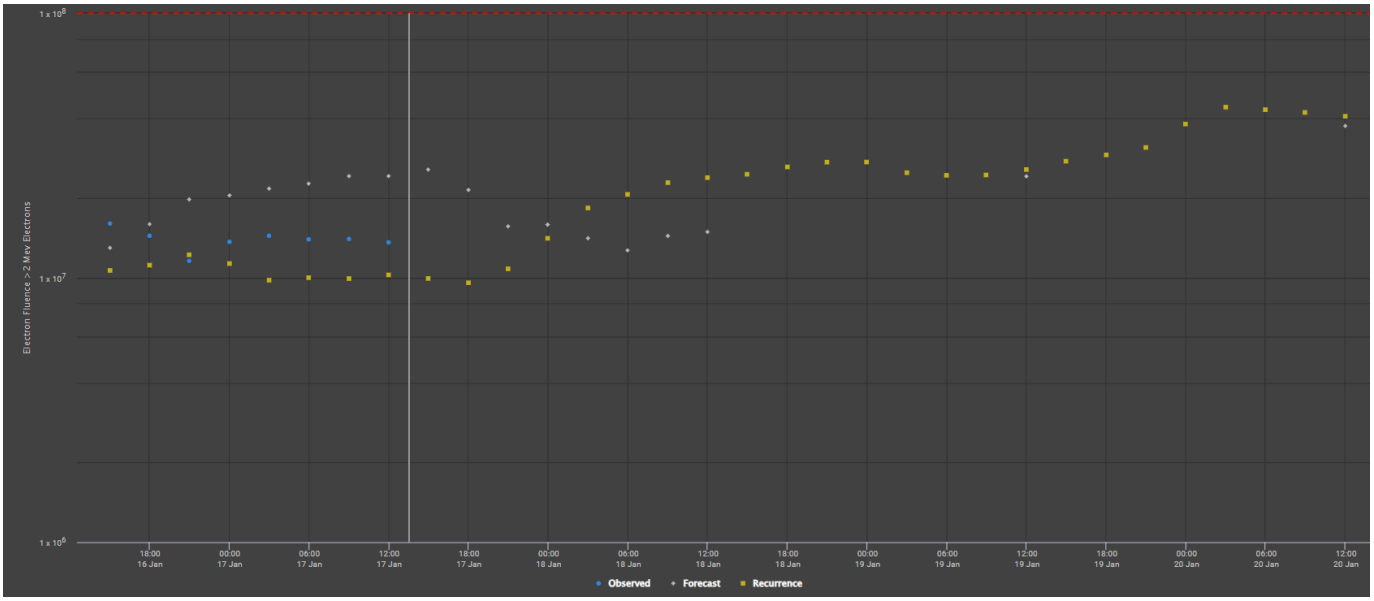
High Energy Electrons (≥ 2MeV)

High energy electron flux observed at GOES16 is currently at moderate levels. Ongoing coronal hole influence is likely to likely to lead to some charging of the Van Allen belts, but potentially result in the majority of this charge persisting below GEO. However, ongoing periods of Moderate flux are likely at diurnal peak, perhaps approaching High at times, most likely later in the period as the fast wind very slowly eases.

Overall, fluence is forecast to remain below Active, but is likely to see a rising trend during the period, which is broadly supported by MOSWOC REFM.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	10	20	30
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 5: MOSWOC REFM



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